

# REPORT No. 613

## THE VARIATION WITH REYNOLDS NUMBER OF PRESSURE DISTRIBUTION OVER AN AIRFOIL SECTION

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### SUMMARY

Pressures were simultaneously measured at 54 orifices distributed over the midspan section of a 5- by 30-inch rectangular model of the N. A. C. A. 4412 airfoil in the variable-density tunnel. These measurements were made at 17 angles of attack from  $-20^\circ$  to  $30^\circ$  for eight values of the effective Reynolds Number from approximately 100,000 to 8,200,000. Accurate data were thus obtained for studying the variation of pressure distribution with Reynolds Number.

These results on the N. A. C. A. 4412 section indicate that the pressure distribution is practically unaffected by changes in Reynolds Number except where separation is involved.

### INTRODUCTION

The need for pressure-distribution data over an airfoil section and the methods of obtaining those data are discussed in detail in reference 1. Briefly, such data provide directly the load distributions required for design purposes and, in addition, the comparison of measured pressures with those computed from potential-flow (nonviscous fluid) theory provides a means of studying the effects of viscous forces on the flow about the airfoil section. Moreover, with the wide range of Reynolds Numbers in use, it is desirable to know how the pressure distribution varies with Reynolds Number. Indications of changes in the character of the flow with Reynolds Number may also be deduced from the measured pressure distributions.

An extensive investigation of the pressure distribution over one section of the N. A. C. A. 4412 airfoil has been carried out in the variable-density wind tunnel. The purpose was twofold: First, to provide adequate experimental data to compare with theoretical results; and second, to study the variations with Reynolds Number. Reference 1 presents the most important phase of the investigation and is divided into two parts. The first part gives a detailed discussion of the experimental technique and a presentation of the results at the highest Reynolds Number. In the second part a comparison is made of experimental with calculated pressure distributions, and a modified method of calcu-

lation, giving more accurate results than those obtained by the usual potential-flow method, is developed.

The present report presents the complete experimental data for the same airfoil at eight values of the Reynolds Number and an analysis of the variations with Reynolds Number.

### APPARATUS AND TESTS

The model used in this pressure-distribution investigation was a standard duralumin airfoil of N. A. C. A. 4412 section with a span of 30 inches and a chord of 5 inches. Pressure orifices, placed in two rows one-quarter inch apart, were located at 54 stations around the midspan section as given in table I. In order to evaluate the pressure force parallel to the chord, a relatively large number of orifices were located at the nose of the airfoil (fig. 1); well-defined distributions of pressure along a normal to the chord were thus assured.

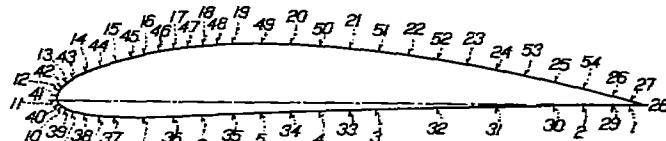


FIGURE 1.—Distribution of pressure orifices about the N. A. C. A. 4412 profile.

Pressures were measured at 17 angles of attack from  $-20^\circ$  to  $30^\circ$  to obtain data throughout the range including the stall at both positive and negative angles of attack. These measurements were made at eight values of the Reynolds Number obtained by varying the density of the air in the tank that houses the tunnel (reference 2). Values of the effective Reynolds Number, obtained by multiplying the test Reynolds Number by the turbulence factor 2.64 (reference 3), and the corresponding tank pressures are given below.

Tank pressure (atmospheres):	Effective Reynolds Number
1/4	$0.10 \times 10^6$
1/2	.24
1	.45
2	.90
4	1.80
8	3.40
15	6.30
21	8.20

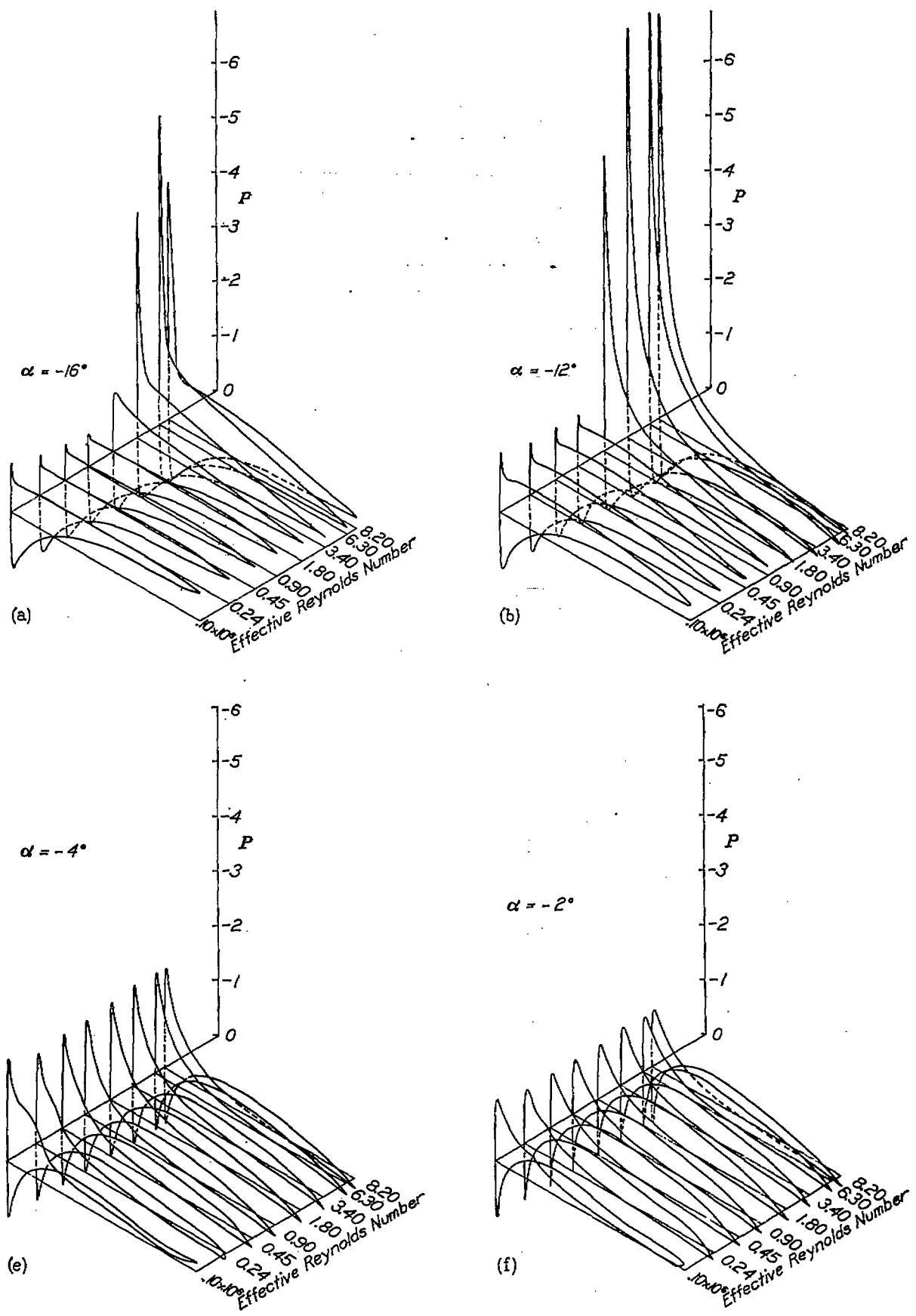


FIGURE 2(a) to 2(p).—Pressure-distribution diagrams for the N. A. C. A. 4412 airfoil.

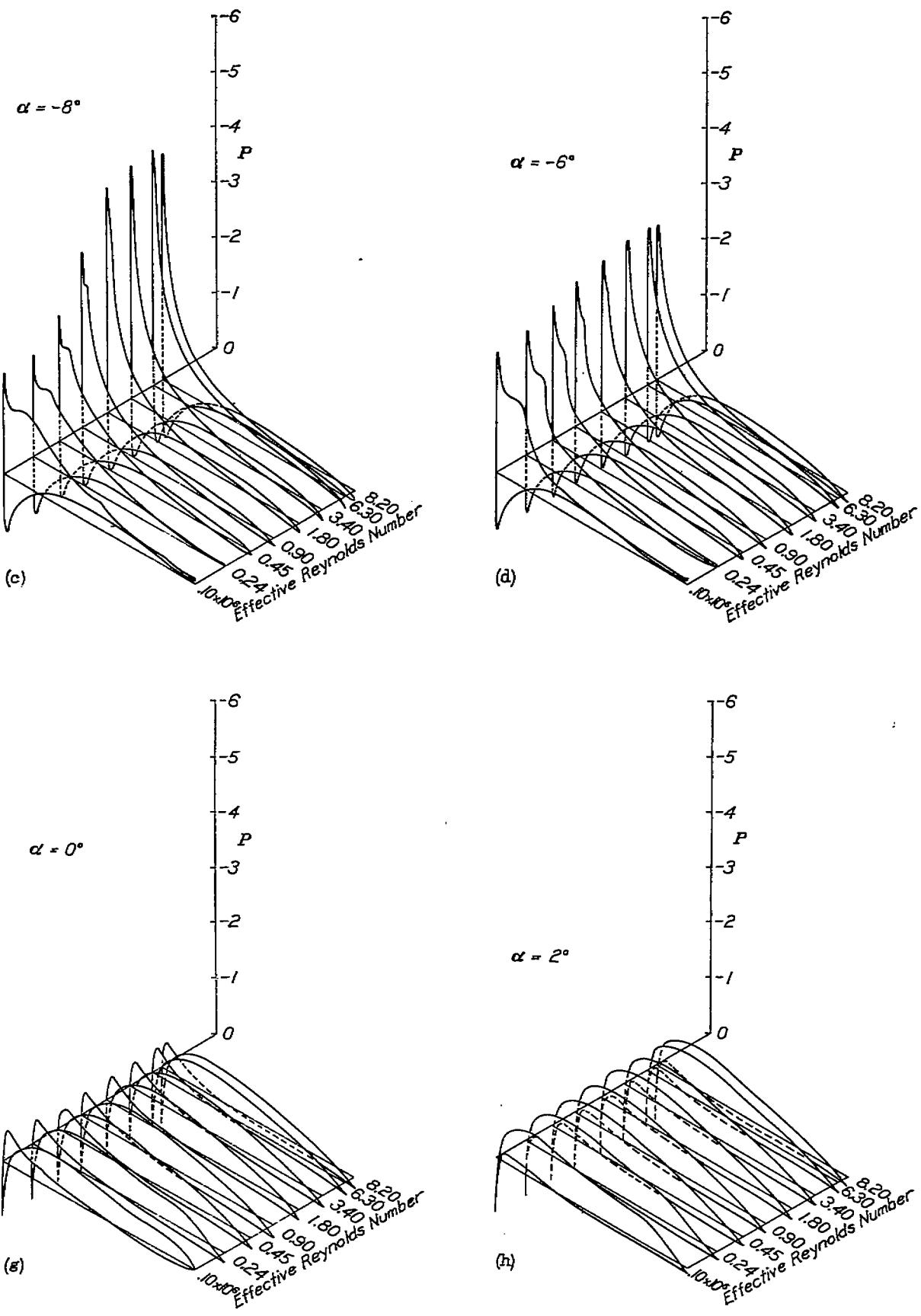


FIGURE 2.—Continued. Pressure-distribution diagrams for the N. A. C. A. 4412 airfoil.

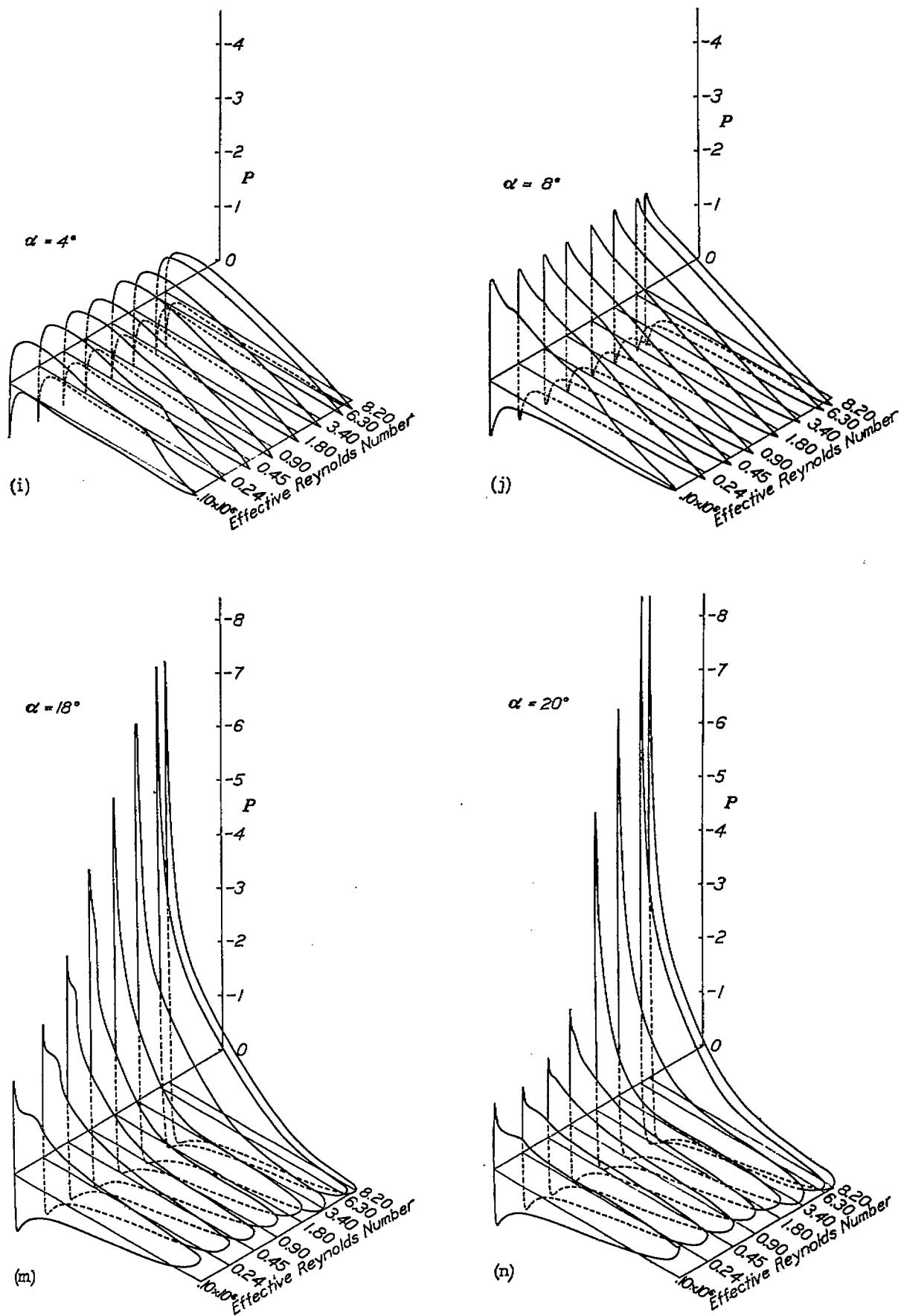


FIGURE 2.—Continued. Pressure-distribution diagrams for the N. A. C. A. 4412 airfoil.

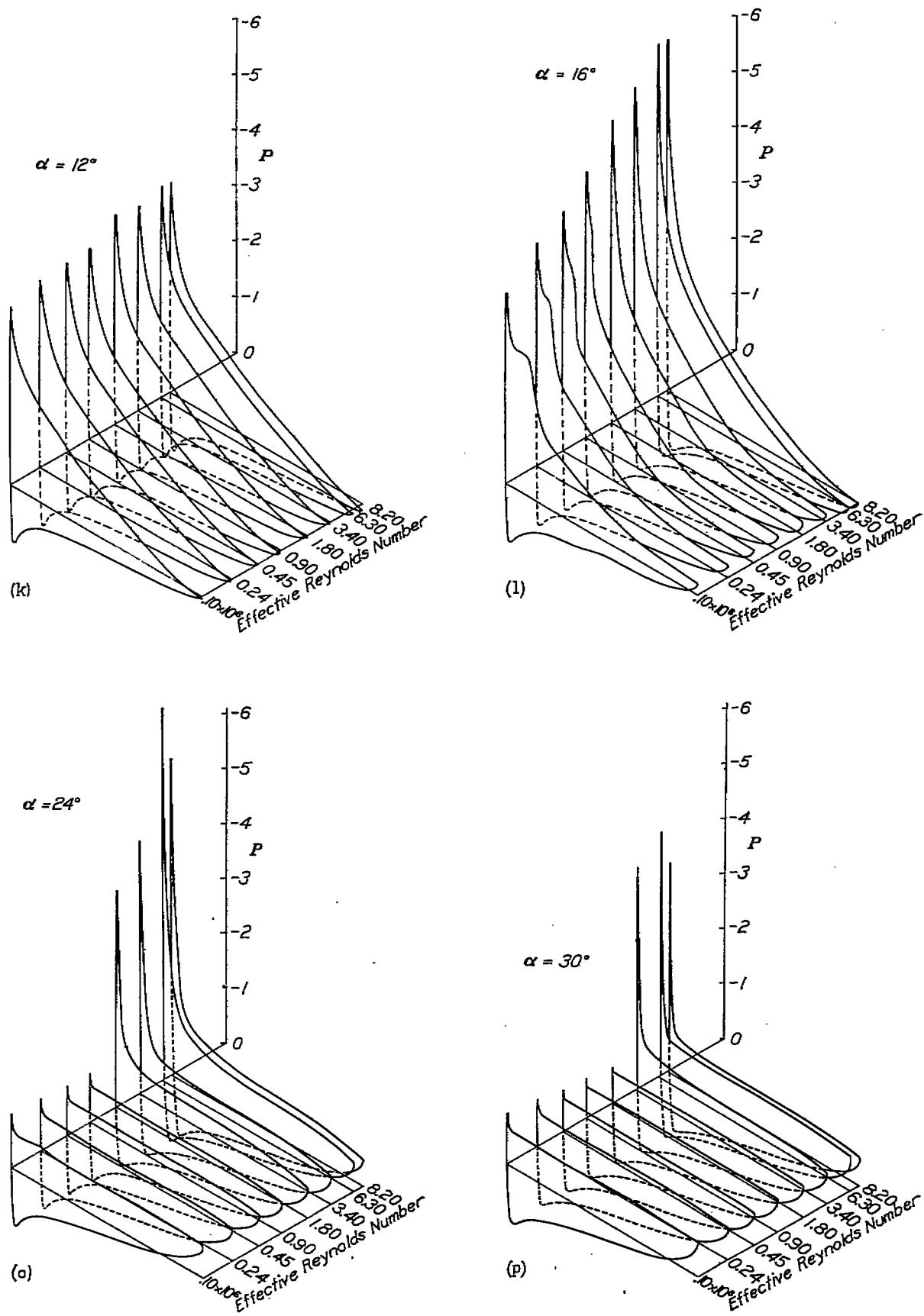


FIGURE 2.—Continued. Pressure-distribution diagrams for the N. A. C. A. 4412 airfoil.

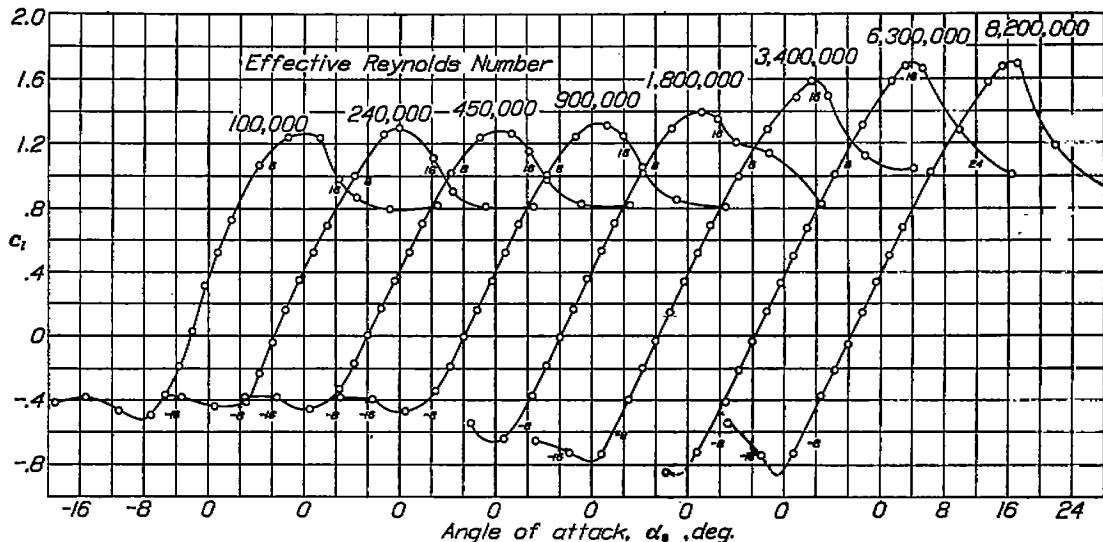


FIGURE 3.—Lift curves for the N.A.C.A. 4412 airfoil at several values of the Reynolds Number.

In order to keep the pressure measurements as accurate as possible, it was necessary to obtain large deflections of the manometer liquids, which was accomplished by using three liquids of widely different specific gravities.

Liquid:	Specific gravity
Mercury	13.6
Tetrabromoethane	3.0
Alcohol	.9

The proper choice of the angle of attack and Reynolds Number groups and of the liquid enabled the use of large and comparable deflections throughout all conditions of the investigation. Repeat tests using the same and different manometer liquids provided data on the precision of the tests.

The values of the pressure coefficient  $P = (p - p_\infty)/q$  at each orifice on the airfoil and for all angles of attack are tabulated in table I; the table is divided into sections (a) to (h), each section comprising the data for one value of the Reynolds Number. The pressures  $p$  and  $p_\infty$  are, respectively, the pressures at the orifice and in the undisturbed stream.

As in reference 1, the data were reduced to the following section coefficients for the midspan section of the airfoil.

$$c_n = \frac{1}{c} \int P dx$$

$$c_c = \frac{1}{c} \int P dy$$

$$c_{m_{c/4}} = \frac{1}{c^2} \left[ \int P(c/4 - x) dx + \int P dy \right]$$

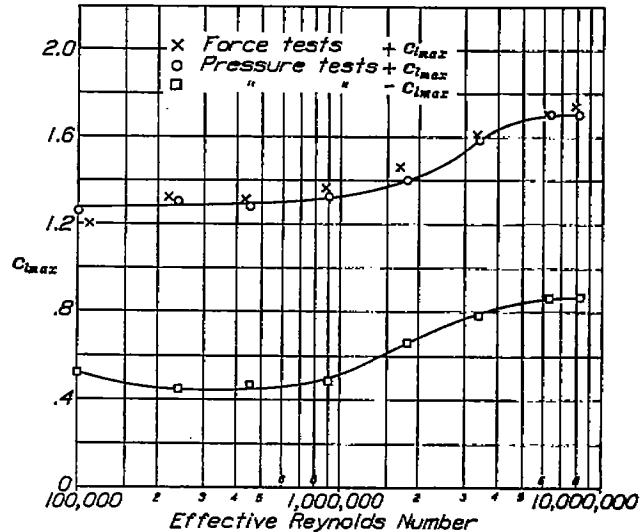
where  $c_n$  is the section normal-force coefficient.

$c_c$ , section chord-force coefficient.

$c_{m_{c/4}}$ , section pitching-moment coefficient.

Lift coefficients were obtained from the pressure measurements by the following equation:

$$c_l = c_n \cos \alpha - c_c \sin \alpha$$

FIGURE 4.—Variation of  $C_{max}$  with Reynolds Number.

The effective angle of attack is given by

$$\alpha_0 = \alpha - \alpha_i$$

and the induced angle of attack of the midspan section by

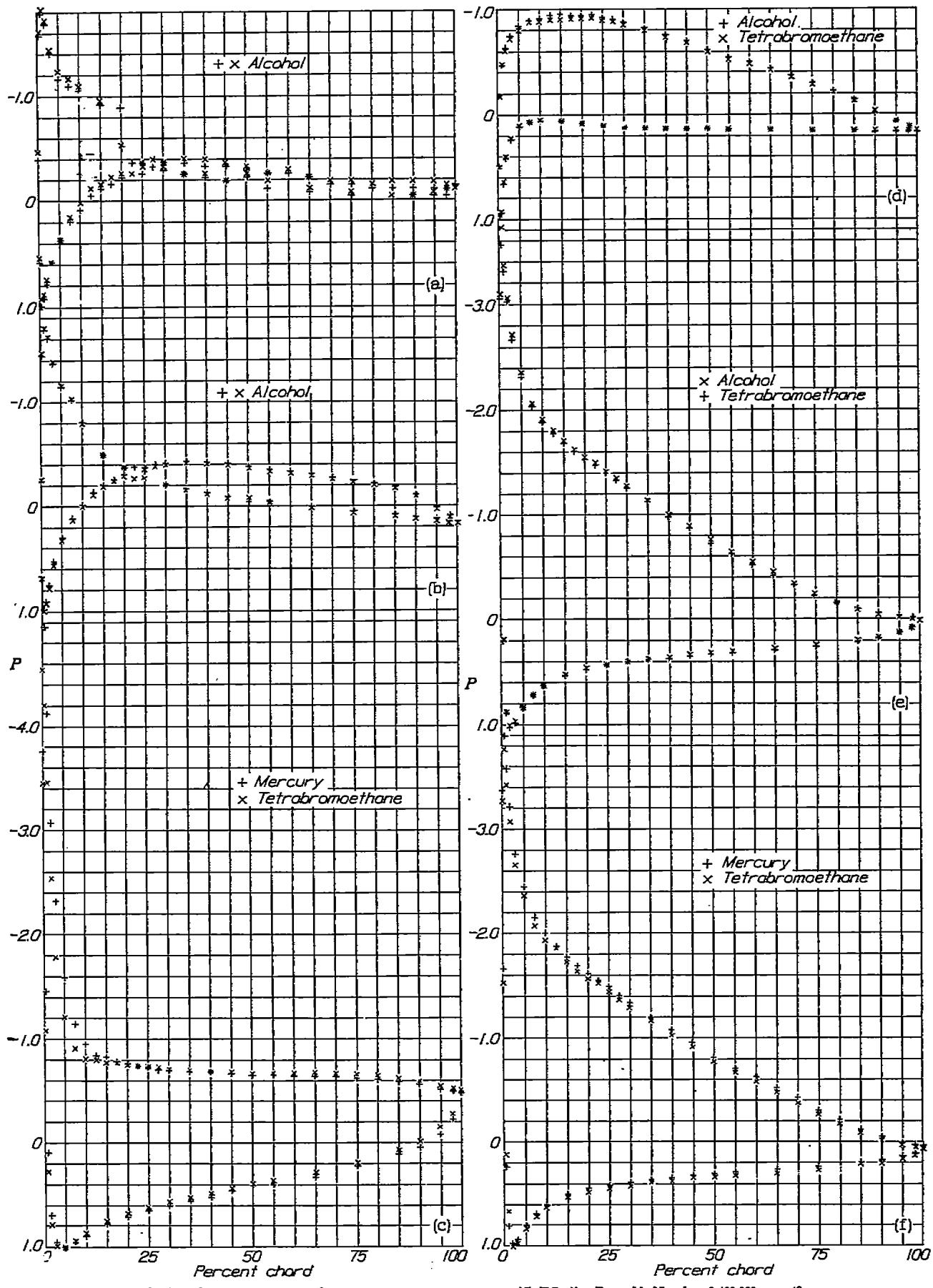
$$\alpha_i = 1.584 c_l$$

where  $\alpha$  is the geometric angle of attack measured from the mean direction of flow in the tunnel.

$\alpha_i$ , the angle that the flow in the region of the airfoil section makes with the direction of the undisturbed flow.

Values of  $c_n$ ,  $c_c$ ,  $c_{m_{c/4}}$ ,  $c_l$ ,  $\alpha_i$ , and  $\alpha_0$  for the 17 values of  $\alpha$  are given in table II; the sections (a) to (h) correspond to the respective Reynolds Numbers of table I(a) to (h).

Isometric plots of normal pressure against position along the chord are presented in figure 2, one set of plots containing the pressures for the eight Reynolds Numbers at each angle of attack. The effect of Reynolds Number on the lift characteristics is shown in figures 3 and 4.



(a) Effective Reynolds Number, 100,000;  $\alpha = -4^\circ$ .  
 (b) Effective Reynolds Number, 450,000;  $\alpha = -4^\circ$ .  
 (c) Effective Reynolds Number, 840,000;  $\alpha = 24^\circ$ .

(d) Effective Reynolds Number, 3,400,000;  $\alpha = 4^\circ$ .  
 (e) Effective Reynolds Number, 1,800,000;  $\alpha = 12^\circ$ .  
 (f) Effective Reynolds Number, 6,300,000;  $\alpha = 12^\circ$ .

FIGURE 5.—Pressure-distribution diagrams from repeat tests at various angles of attack and values of the Reynolds Number. Values indicated by X are also given in table I.

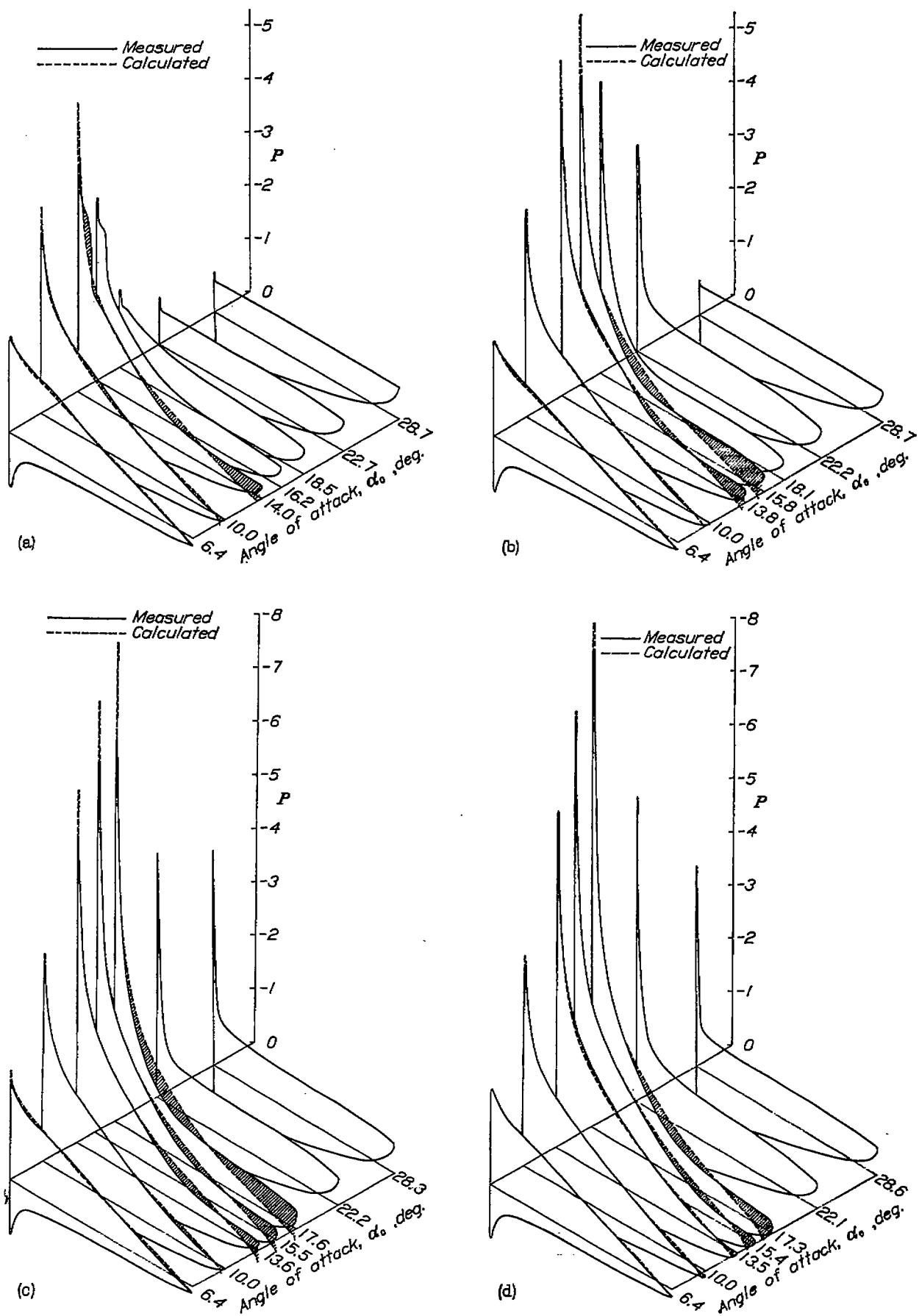


FIGURE 6.—Pressure-distribution diagrams showing the spread of separation at four values of the Reynolds Number.

### PRECISION

The precision of the pressure measurements at Reynolds Numbers other than that for the data published in reference 1 is indicated by the diagrams given in figure 5. At the lowest Reynolds Number (fig. 5 (a)) the capacity to repeat measured pressures is markedly less than for higher Reynolds Numbers. It should be noted, however, that the precision was good enough to establish the occurrence of the supposedly laminar separation near the leading edge. The precision at Reynolds Numbers corresponding to the atmospheric runs and at higher values is consistently good even when the section has stalled, as in the diagram for 24°.

### DISCUSSION

The general nature of the variation of the pressure distribution with Reynolds Number may be observed by means of the isometric plots in figure 2. At normal angles of attack, where stalling is not involved, the distributions are practically unaffected and hence the modified method of calculation presented in reference 1 is applicable at those attitudes for any Reynolds Number. Differences that do occur in the pressure diagrams are entirely of a local nature; they are probably associated with separation and the changes in the character of the boundary layer as the Reynolds Number is varied.

**Boundary layer and the pressure distribution.**—The formation of the boundary layer due to the viscous forces and the resulting effect on the pressure distribution is discussed in reference 1. A comparison of actual pressures with those computed for a potential, or non-viscous, fluid led to the development of the previously mentioned modified method of calculation, which gives good results at attitudes where separation is not involved.

Separation of the flow from the surface would be expected to be indicated on the pressure diagrams by a region of approximately constant pressures. The start and growth of separation are best observed in figure 6, which presents isometrically the pressure diagrams for an increasing angle-of-attack range. Calculated diagrams obtained by the method of reference 1 for a non-separated viscous flow are superposed for comparison. The differences between the measured and calculated distributions are attributed to separation and hence the shaded area may be considered as a measure of the effect of separation. The inclusion of four groups of diagrams, one for each of four values of the Reynolds Number, provides a means of studying the scale effect on separation phenomena.

The occurrence of separation is markedly affected by changes in the Reynolds Number, as may be seen in figure 6. Moreover, the only observable scale effects on pressure distributions (fig. 2) are probably due to the nature of the separation and the changes in the separa-

tion phenomena experienced with changing Reynolds Number. Most of these changes, of course, appear near either the positive or negative stall but at low Reynolds Numbers (below  $R_e = 900,000$  approximately) some effects of separation, even in the low-drag range, are apparent from a careful analysis of the distributions. The presence of some such effects is indicated especially by pressure-drag integrations which, in this range, show a definite increase of drag with decreasing Reynolds Number. These results, however, are not presented as such since pressure-drag determinations are subject to some uncertainty owing to the inherent difficulty in obtaining them. The following analysis is based on changes in pressure distribution occurring near the stall.

A detailed discussion of these phenomena based on analyses of force tests of a large number of airfoils of widely different shapes is given in reference 3. The pressure-distribution data presented herein provide confirmatory and supplementary information for one particular type of airfoil section represented by the N. A. C. A. 4412 airfoil. This airfoil is one of medium thickness and camber producing a fairly gradual stall (type D lift-curve peak, reference 3). The stalling process of this section is a complicated one involving both trailing- and leading-edge types of separation.

At the low Reynolds Number (fig. 6 (a)) separation occurs prior to the stall as indicated in two distinct regions on the N. A. C. A. 4412 airfoil: One in the turbulent boundary layer near the rear of the airfoil, and the other in what is probably the laminar boundary layer near the nose. Instability of the laminar flow after separation results in a breakdown of the smooth laminae into an eddying flow. The scouring action of the eddying flow may then sweep the dead air from the surface and cause the reestablishment of unseparated flow with a turbulent boundary layer instead of the laminar layer. This laminar separation and the subsequent establishment of eddying flow account for the so-called "bubble" of dead air occurring in the flow at the low Reynolds Numbers. The turbulent layer, unable to maintain itself at high angles of attack, starts separating near the trailing edge and spreads forward as the angle is increased until the stall, resulting from the combined laminar and turbulent separations, is reached.

At the highest Reynolds Numbers (fig. 6) marked local laminar separation near the nose of the airfoil is apparently prevented. This prevention is accounted for by a transition from laminar to turbulent flow nearly at the laminar separation point or before the laminar flow has reached separation conditions. A movement forward of this transition region with increasing Reynolds Number has been observed in smoke-flow studies. Moreover, figure 6 indicates that, for the N. A. C. A. 4412 airfoil in the Reynolds Number range included, the separation in the turbulent bound-

ary layer is slightly delayed with increasing Reynolds Number. Hence, at the high Reynolds Number, with possibly a delayed turbulent separation and no marked local laminar separation, the airfoil section increased its lift to a higher angle before stalling than was possible at the low Reynolds Number.

This analysis of the separation phenomena and the changes with Reynolds Number has been confirmed in some respects by measurements in the boundary layer of the N. A. C. A. 4412 airfoil at several values of the Reynolds Number. These data are a part of an N. A. C. A. investigation of boundary-layer phenomena.

**Concluding remarks.**—The results of this investigation indicate that the pressure distribution except near maximum lift is practically unaffected by changes in the Reynolds Number above a certain critical value, which is below the usual full-scale range. This critical

value is probably the value at which there is no definite local separation.

LANGLEY MEMORIAL AERONAUTICAL LABORATORY,  
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS,  
LANGLEY FIELD, VA., *July 14, 1937.*

#### REFERENCES

1. Pinkerton, Robert M.: Calculated and Measured Pressure Distributions Over the Midspan Section of the N. A. C. A. 4412 Airfoil. T. R. No. 563, N. A. C. A., 1936.
2. Jacobs, Eastman N., and Abbott, Ira H.: The N. A. C. A. Variable-Density Wind Tunnel. T. R. No. 416, N. A. C. A., 1932.
3. Jacobs, Eastman N., and Sherman, Albert: Airfoil Section Characteristics as Affected by Variations of the Reynolds Number. T. R. No. 586, N. A. C. A., 1937.

TABLE Ia.—EXPERIMENTAL DATA

[N. A. C. A. 4112 airfoil; effective Reynolds Number, 100,000; test, variable-density tunnel 1007-4; manometer liquid, alcohol]

VARIATION WITH REYNOLDS NUMBER OF PRESSURE DISTRIBUTION OVER AN AIRFOIL

TABLE Ib.—EXPERIMENTAL DATA

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 240,000; test, variable-density tunnel 1097-3; manometer liquid, alcohol]

TABLE Ic.—EXPERIMENTAL DATA

[N. A. C. A. 4112 airfoil; effective Reynolds Number, 450,000; test, variable-density tunnel 1097-1; manometer liquid, alcohol]

Orifices			Values of pressure coefficient, $P = \frac{P - P_\infty}{\rho}$ , for different angles of attack																
Designation	Station (percent c from L. B. of chord)	Ordinate (percent c above chord)	-20°	-10°	-12°	-8°	-6°	-4°	-2°	0°	2°	4°	8°	12°	16°	18°	20°	24°	30°
28	100.00	0	-0.477	-0.896	-0.201	0.067	0.148	0.164	0.172	0.172	0.156	0.181	0.002	-0.234	-0.384	-0.461	-0.558	-0.568	
1	97.92	-1.16	-0.488	-1.420	-0.209	0.088	0.148	0.164	0.158	0.172	0.148	0.088	-1.104	-1.218	-1.274	-1.390	-1.366		
20	94.88	-1.18	-0.502	-1.458	-0.242	0.075	0.181	0.148	0.140	0.148	0.172	0.164	-1.015	-1.108	-1.161	-1.260	-1.209		
2	89.90	-1.22	-0.518	-1.485	-0.263	0.088	0.115	0.128	0.131	0.160	0.172	0.180	0.150	0.085	.002	-1.047	-1.120	-1.071	
30	84.94	-1.28	-0.526	-1.518	-0.223	0.084	0.083	0.107	0.123	0.148	0.169	0.198	0.172	0.128	0.068	0.026	-1.047	-1.010	
31	74.92	-1.52	-0.526	-1.584	-0.404	-0.015	0.042	0.087	0.075	0.108	0.145	0.169	0.218	0.231	0.205	0.166	0.181	0.076	0.148
32	64.94	-1.84	-0.526	-1.542	-0.485	-0.071	-0.006	0.018	0.050	0.088	0.123	0.169	0.221	0.253	0.261	0.231	0.218	0.164	0.246
8	54.48	-1.24	-0.518	-1.542	-0.575	-0.158	-0.063	-0.031	-0.001	0.058	0.117	0.148	0.220	0.278	0.310	0.278	0.269	0.237	0.335
33	49.93	-1.44	-0.502	-1.534	-0.615	-0.198	-0.098	-0.080	-0.006	0.034	0.091	0.148	0.221	0.296	0.334	0.318	0.310	0.278	0.388
4	44.90	-1.64	-0.502	-1.526	-0.656	-0.242	-0.128	-0.080	-0.031	0.026	0.091	0.145	0.245	0.310	0.367	0.343	0.318	0.242	
34	39.98	-1.88	-0.502	-1.526	-0.689	-0.307	-0.160	-0.112	-0.055	0.010	0.075	0.131	0.253	0.384	0.388	0.378	0.367	0.351	0.404
5	34.90	-2.10	-0.502	-1.518	-0.713	-0.388	-0.200	-0.188	-0.080	0.018	0.067	0.131	0.261	0.361	0.415	0.407	0.391	0.305	
35	29.95	-2.30	-0.494	-1.518	-0.729	-0.494	-0.274	-0.201	-0.120	-0.065	0.042	0.115	0.269	0.375	0.464	0.448	0.440	0.432	0.545
6	24.90	-2.54	-0.485	-1.510	-0.729	-0.615	-0.304	-0.274	-0.177	-0.104	0.010	0.117	0.278	0.417	0.497	0.489	0.481	0.472	0.594
36	19.93	-2.76	-0.485	-1.502	-0.729	-0.709	-0.477	-0.372	-0.268	-0.161	-0.023	0.091	0.294	0.422	0.587	0.587	0.521	0.513	0.651
7	14.94	-2.90	-0.477	-1.494	-0.721	-0.940	-0.628	-0.494	-0.404	-0.218	-0.055	0.075	0.328	0.497	0.610	0.610	0.494	0.504	0.732
37	9.95	-2.88	-0.488	-1.494	-0.718	-1.200	-0.818	-0.794	-0.568	-0.315	-0.120	-0.088	0.375	0.588	0.718	0.707	0.692	0.692	0.821
8	7.88	-2.72	-0.477	-1.485	-0.696	-1.476	-1.408	-1.029	-0.648	-0.372	-0.128	-0.075	0.440	0.675	0.818	0.797	0.773	0.765	0.886
38	4.94	-2.46	-0.477	-1.485	-0.688	-1.738	-1.727	-1.189	-0.786	-0.445	-0.186	-0.125	0.554	0.797	0.919	0.903	0.878	0.862	0.959
9	2.92	-2.06	-0.409	-1.477	-0.680	-1.719	-1.841	-1.386	-0.932	-0.477	-0.237	-0.176	0.727	0.927	0.903	0.976	0.969	1.000	
39	1.66	-1.60	-0.469	-0.477	-0.672	-1.687	-2.101	-1.622	-1.013	-0.445	-0.084	0.416	0.894	0.902	0.919	0.919	1.000	0.934	0.927
10	.92	-1.20	-0.469	-0.485	-0.698	-1.904	-1.703	-1.940	-1.260	-0.778	-0.661	1.000	0.870	0.595	0.686	0.994	0.888	0.724	
40	.36	-0.70	-0.526	-0.623	-0.932	-2.289	-2.377	-1.408	-1.574	-1.168	-0.659	0.919	0.903	0.231	0.502	1.815	0.888	0.458	
11	0	0	-0.618	-1.494	-0.542	-1.224	-1.087	-1.268	-0.888	-0.818	-0.984	-0.944	-1.08	-1.205	-2.500	-2.019	-1.648	-1.855	-0.599
41	0	.68	.036	.237	.802	.067	.351	.083	.935	.984	.854	.411	.891	.215	.403	.8407	.1.451	.891	.745
12	.44	1.56	.766	.878	.919	.886	.959	1.000	.935	.708	.351	.185	.684	.838	.475	.321	.330	.680	.567
42	.94	2.16	.951	.992	1.000	1.000	1.000	.927	.748	.448	.042	.458	.744	.818	.846	.810	.1.192	.648	.567
13	1.70	2.78	1.000	1.000	.984	.968	.927	.781	.554	.287	.136	.569	.719	.912	.578	.2.012	.1.195	.640	.588
43	2.94	8.04	.976	.019	.870	.890	.740	.662	.518	.010	.328	.721	.616	.620	.844	.2.896	.1.183	.640	.591
14	4.90	4.08	.870	.778	.700	.635	.529	.326	.098	.185	.485	.826	.1.573	.2.869	.8.826	.2.612	.1.167	.648	.591
44	7.50	5.74	.724	.019	.521	.448	.326	.181	.080	.928	.583	.807	.1.484	.2.125	.2.068	.1.800	.1.062	.666	.591
15	9.06	5.56	.610	.490	.300	.310	.188	.002	.188	.420	.648	.899	.1.427	.1.980	.1.922	.1.872	.997	.648	.575
45	12.68	7.84	.489	.367	.269	.172	.067	.112	.201	.602	.708	.892	.1.394	.1.800	.1.883	.1.900	.996	.648	.575
16	14.92	7.88	.599	.296	.188	.091	.1.015	.1.185	.347	.842	.729	.932	.1.346	.1.708	.1.711	.1.394	.916	.640	.575
46	17.44	8.40	.818	.205	.115	.036	.080	.242	.808	.607	.737	.932	.1.306	.1.597	.1.589	.1.281	.888	.640	.591
17	19.90	8.80	.245	.128	.042	.039	.186	.291	.487	.599	.761	.932	.1.278	.1.582	.1.484	.1.162	.859	.640	.575
47	23.44	9.16	.140	.042	.081	.104	.242	.266	.477	.628	.737	.859	.1.192	.1.838	.1.110	.859	.688	.631	
18	24.92	9.52	.115	.010	.056	.128	.218	.356	.426	.623	.761	.907	.1.192	.1.888	.1.013	.810	.681	.575	
48	27.44	9.62	.058	.088	.104	.168	.268	.380	.510	.640	.761	.899	.1.189	.1.821	.1.200	.940	.785	.681	.575
19	29.88	9.76	.018	.080	.128	.193	.274	.398	.510	.631	.748	.887	.1.127	.1.268	.1.004	.867	.709	.681	.588
49	34.98	9.90	-.063	-1.44	-1.185	-1.226	-1.299	-1.412	-1.502	-1.615	-1.705	-1.810	-1.029	-1.127	-1.918	-1.745	-1.721	.681	.588
50	39.90	9.84	-.120	-1.85	-1.201	-1.242	-1.299	-1.404	-1.488	-1.576	-1.664	-1.761	-1.932	-1.981	-1.745	-1.648	-1.631	-1.591	
44	44.80	9.64	-.185	-1.284	-1.234	-1.258	-1.315	-1.396	-1.469	-1.542	-1.623	-1.705	-1.834	-1.883	-1.615	-1.533	-1.680	-1.640	-1.591
51	49.92	9.22	-.209	-1.250	-1.242	-1.242	-1.291	-1.364	-1.457	-1.494	-1.567	-1.668	-1.708	-1.745	-1.494	-1.542	-1.644	-1.640	-1.591
52	54.92	8.76	-.234	-1.234	-1.226	-1.208	-1.281	-1.381	-1.398	-1.403	-1.518	-1.607	-1.699	-1.740	-1.404	-1.502	-1.640	-1.640	-1.591
53	59.04	8.16	-.274	-.291	-.260	-.218	-.260	-.815	-.864	-.420	-.485	-.534	-.584	-.642	-.847	-.494	-.631	-.648	-.501
54	64.90	7.54	-.315	-.215	-.258	-.209	-.284	-.291	-.389	-.388	-.445	-.437	-.469	-.445	-.828	-.477	-.623	-.658	-.607
55	69.88	6.76	-.389	-.328	-.250	-.185	-.209	-.258	-.307	-.347	-.384	-.347	-.388	-.387	-.299	-.461	-.615	-.656	-.599
56	74.90	5.88	-.364	-.389	-.260	-.161	-.177	-.226	-.274	-.299	-.291	-.292	-.209	-.266	-.282	-.461	-.607	-.656	-.599
57	79.92	4.92	-.347	-.242	-.136	-.144	-.201	-.234	-.281	-.309	-.193	-.217	-.185	-.266	-.445	-.615	-.648	-.599	
58	84.88	8.88	-.412	-.364	-.226	-.104	-.120	-.169	-.161	-.112	-.128	-.144	-.128	-.104	-.266	-.429	-.567	-.681	-.591
59	89.88	2.74	-.429	-.364	-.209	-.071	-.088	-.066	-.047	-.080	-.059	-.055	-.055	-.065	-.268	-.420	-.550	-.575	
60	94.90	1.48	-.461	-.380	-.193	-.047	-.006	-.084	-.060	-.050	-.050	-.042	-.060	-.028	-.260	-.404	-.501	-.591	
61	98.88	0.68	-.477	-.388	-.185	-.010	.001	.115	.123	.128	.118	.002	.242	-.380	-.477	-.507	-.507	-.508	
62	100.00	0																	

TABLE Ia.—EXPERIMENTAL DATA

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 900,000; test, variable-density tunnel, 1097-2; manometer liquid, alcohol]

## VARIATION WITH REYNOLDS NUMBER OF PRESSURE DISTRIBUTION OVER AN AIRFOIL

TABLE Ie.—EXPERIMENTAL DATA

[N. A. C. A. 4112 airfoil; effective Reynolds Number 1,800,000; test numbers and manometer liquids given in footnotes]

Orifices			Values of pressure coefficient, $P = \frac{p - p_\infty}{q}$ , for different angles of attack																	
Designation	Station (percent c from L. E. of chord)	Ordinate (percent c above chord)	-20°	-16°	-12°	-8°	-6°	-4°	-2°	0°	+2°	+4°	+8°	+12°	+16°	+18°	+20°	+24°	+30°	
28	100.00	0	-0.809	0.048	0.181	0.198	0.199	0.201	0.198	0.191	0.178	0.134	0.016	-0.194	-0.324	-0.381	-0.547	-0.540		
1	87.92	1.16	-0.889	0.048	0.158	0.170	0.176	0.178	0.170	0.173	0.154	0.085	-0.088	-0.187	-0.209	-0.317	-0.328			
29	94.80	1.16	-0.852	0.000	0.130	0.146	0.154	0.158	0.154	0.160	0.168	0.170	0.180	0.029	-0.036	-0.094	-0.187	-0.187		
2	89.90	1.22	-0.888	-0.029	0.097	0.116	0.128	0.130	0.138	0.138	0.148	0.151	0.178	0.115	0.065	-0.029	-0.080	-0.180		
30	86.94	1.28	-0.810	0.072	0.067	0.099	0.103	0.128	0.120	0.160	0.160	0.201	0.208	0.173	0.137	0.108	0.043	0.086		
31	74.92	-1.62	-0.407	1.144	0.012	0.048	0.067	0.089	0.105	0.140	0.165	0.219	0.249	0.245	0.230	0.216	0.165	0.165		
32	64.94	-8.84	-0.525	2.223	-0.047	0.101	0.024	0.056	0.083	0.126	0.158	0.281	0.280	0.302	0.302	0.295	0.381	0.381		
3	54.48	-1.24	-0.576	2.205	1.120	-0.071	-0.028	0.014	0.053	0.108	0.143	0.239	0.305	0.344	0.358	0.360	0.381	0.381		
33	49.98	-1.44	-0.597	1.410	0.158	0.101	0.063	0.004	0.034	0.093	0.140	0.248	0.320	0.374	0.398	0.398	0.398			
4	44.90	-1.04	-0.626	1.888	-0.199	-0.186	0.079	0.024	0.028	0.098	0.142	0.246	0.341	0.403	0.417	0.482	0.410	0.422		
34	89.98	-8.86	-0.640	-1.460	-0.247	-0.174	-0.110	-0.047	0.014	0.085	0.140	0.266	0.363	0.439	0.483	0.468	0.458	0.475		
5	84.90	-2.10	-0.676	1.498	-0.306	-0.228	-0.160	-0.075	0.006	0.073	0.134	0.276	0.385	0.468	0.489	0.511	0.490	0.526		
25	29.98	-8.80	-0.691	1.690	-0.379	-0.284	-0.199	-0.112	0.030	0.053	0.128	0.244	0.410	0.504	0.525	0.547	0.532	0.558		
6	24.90	-2.14	-0.727	1.689	-0.491	-0.377	-0.274	-0.170	0.075	0.118	0.198	0.290	0.434	0.547	0.566	0.590	0.619			
36	18.98	-3.76	-0.755	1.791	-0.637	-0.497	-0.371	-0.247	0.138	0.200	0.301	0.469	0.597	0.620	0.655	0.640	0.669			
7	14.94	-2.90	-0.784	-1.007	-0.848	-0.671	-0.607	-0.349	-0.217	-0.081	0.075	0.327	0.523	0.662	0.698	0.727	0.712	0.741		
37	9.96	-8.86	-0.892	-1.881	-1.169	-0.987	-0.712	-0.525	-0.312	-0.110	0.069	0.385	0.631	0.777	0.820	0.849	0.820	0.834		
8	7.38	-2.72	-0.942	-1.876	-1.450	-1.180	-0.882	-0.643	-0.386	-0.128	0.083	0.454	0.708	0.868	0.909	0.928	0.906	0.909		
38	4.94	-3.46	-0.971	-2.151	-1.842	-1.608	-1.191	-0.789	-0.486	-0.184	0.130	0.556	0.826	0.987	1.014	1.044	0.971			
9	2.92	-2.00	-1.007	-2.921	-2.785	-2.079	-1.456	-0.941	-0.473	-0.081	0.249	0.730	0.903	1.007	1.000	1.022	1.000	1.007		
39	1.66	-1.80	-0.978	-4.072	-8.881	-2.406	-1.698	-1.024	-0.428	0.049	0.436	0.901	1.008	0.878	0.806	0.820	0.856	0.925		
10	.02	-1.20	-1.038	-4.028	-8.761	-2.666	-1.783	-1.065	-0.428	0.088	0.482	1.006	0.870	0.432	0.268	0.410	0.727			
40	.38	1.70	-1.007	-5.890	-4.018	-2.651	-1.547	-0.584	-0.176	0.660	0.983	0.905	0.185	0.921	-1.259	-1.201	-0.019	1.44		
11	0	0	-1.023	-8.908	-2.863	-1.181	-0.281	-0.400	0.830	0.939	0.987	0.178	1.438	-8.802	-8.799	-8.604	-2.691	-1.583		
41	0	.68	-1.187	-1.655	-0.497	.223	0.088	0.947	0.844	0.844	0.458	-0.974	-8.007	-5.295	-5.820	-5.468	-3.076	-1.640		
12	.44	1.58	.748	.817	.769	.955	1.004	.988	.686	.312	-1.281	-1.765	-8.722	-5.403	-5.765	-5.892	-8.878	-1.588		
42	.94	2.16	.957	.906	.976	1.000	.938	.747	.424	.028	-1.487	-1.808	-8.367	-4.820	-5.181	-4.768	-3.286	-1.570		
13	1.70	2.78	1.014	.996	.994	.928	.781	.546	.207	.176	.046	-1.769	-3.065	-4.288	-4.360	-3.849	-2.654	-1.668		
43	2.94	3.04	.971	.990	.884	.744	.562	.810	.014	-0.857	-1.869	-2.718	-8.338	-3.845	-2.985	-1.410	-1.661			
14	4.90	4.68	.835	.871	.094	.523	.828	.083	-0.217	-0.517	-0.862	-1.562	-2.863	-2.892	-2.860	-2.388	-1.273	-1.561		
44	7.50	5.74	.688	.705	.407	.825	.188	.087	-0.358	-0.611	-1.001	-1.495	-2.065	-2.475	-2.874	-1.892	-1.020	-1.564		
15	6.98	6.66	.604	.688	.358	.185	.006	.201	-0.444	-0.678	-0.920	-1.488	-1.909	-2.230	-2.079	-1.532	-1.004	-1.554		
45	13.68	7.84	.432	.446	.226	.061	.108	.300	.528	.780	.950	.108	-0.398	-1.805	-2.048	-1.261	-1.892	-1.554		
16	14.92	7.88	.845	.380	.140	.016	.174	.385	.800	.748	.957	-1.847	-1.708	-1.892	-1.047	-1.065	1.561			
46	17.44	8.40	.269	.266	.061	.085	.284	.100	.594	.957	-1.302	-1.628	-1.703	-1.489	-1.935	1.849	-1.661			
17	10.98	8.80	.187	.201	-.006	-.146	-.285	-.444	-.623	-.788	-.955	-.204	-1.548	-1.840	-1.817	1.784	1.842	1.561		
47	22.44	9.16	.123	.129	.163	.197	.329	.479	.645	.768	.951	-.285	-1.493	-1.547	-1.187	1.719	1.827	1.561		
18	24.92	9.32	.072	.086	.108	.231	.389	.497	.658	.791	.957	-.189	-1.414	-1.480	-1.029	1.640	1.827	1.561		
48	27.44	9.62	.022	.036	.148	.266	.388	.618	.657	.785	.921	-.146	-1.347	-1.324	-1.914	1.612	1.820	1.668		
19	29.98	9.76	-.007	.000	.172	.284	.304	.517	.053	.771	.897	-1.098	1.274	-1.216	1.701	1.568	1.827	1.568		
49	84.98	9.90	.079	.088	.211	.310	.408	.515	.688	.732	.842	-1.002	-1.140	-1.029	-0.662	-0.554	-0.818	1.576		
50	89.90	9.84	.122	.096	.215	.312	.388	.491	.504	.600	.771	.892	.998	.827	.558	.582	.813	.583		
51	44.80	9.04	.165	.122	.241	.320	.394	.477	.568	.641	.713	.819	.890	.076	.532	.532	.906	.593		
52	49.92	9.22	.172	.115	.227	.204	.387	.428	.507	.666	.619	.708	.758	.518	.504	.525	.777	.593		
53	54.92	8.76	.104	.120	.213	.270	.325	.385	.460	.498	.542	.617	.689	.489	.511	.532	.791	.590		
22	50.94	8.16	-.209	-.137	-.211	-.258	-.804	-.359	-.412	-.448	-.495	-.548	-.542	-.307	-.489	-.525	-.748	-.583		
54	64.90	7.54	.287	.144	.201	.241	.280	.326	.367	.400	.483	.471	.444	.345	.496	.532	.770	.590		
23	69.88	6.78	.252	.197	.218	.218	.243	.278	.314	.341	.371	.395	.380	.317	.463	.526	.755	.590		
24	74.90	5.88	.280	.129	.174	.199	.227	.260	.278	.298	.298	.241	.302	.475	.518	.785	.590			
55	79.92	4.92	.280	.123	.123	.140	.168	.178	.203	.215	.229	.213	.150	.268	.463	.511	.772	.590		
25	84.88	3.88	.280	.108	.088	-.098	-.105	-.120	-.188	-.142	-.160	-.120	-.087	-.273	-.463	-.504	-.691	-.576		
56	89.88	2.74	.287	.079	-.026	-.080	-.085	-.041	-.051	-.063	-.020	-.089	-.260	-.482	-.647	-.608				
26	94.90	1.48	.295	.029	.043	.049	.053	.081	.047	.056	.067	.012	-.252	-.306	-.489	-.612	-.584			
57	95.00	.68	.324	.007	.105	.118	.126	.128	.124	.128	.114	.004	-.230	-.360	-.410	-.583	-.547			
28	100.00	0																		

\* Test, variable-density tunnel 1069-1; manometer liquid, tetrabromomethane.

† Test, variable-density tunnel 1097-5; manometer liquid, alcohol.

TABLE II.—EXPERIMENTAL DATA

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 3,400,000; test numbers and manometer liquids given in footnotes]

Orifices			Values of pressure coefficient, $P - P_\infty$ , for different angles of attack																
Designation	Station (percent c from L. E. of chord)	Ordinate (percent c above chord)	-20°	-18°	-12°	-8°	-6°	-4°	-2°	0°	2°	4°	6°	12°	16°	18°	20°	24°	30°
28	100.00	0	-0.378	-0.170	0.178	0.193	0.196	0.200	0.186	0.175	0.160	0.110	0.013	-0.134	-0.178	-0.388	-0.511	-0.568	
1	97.92	-16	-406	-177	.167	.168	.182	.168	.182	.171	.160	.132	.082	.006	.061	-.019	-.288	-.324	
29	94.86	-16	-432	-209	.128	.130	.157	.146	.160	.157	.164	.163	.166	.128	.085	.134	-.077	-.152	-.177
2	89.90	-22	-468	-249	.092	.103	.125	.121	.142	.146	.164	.157	.178	.176	.164	.220	.188	-.019	-.033
30	84.94	-28	-493	-292	.056	.074	.099	.103	.128	.139	.160	.160	.190	.208	.214	.288	.230	.067	.067
31	74.92	-82	-539	-885	-015	.020	.053	.007	.009	.121	.149	.160	.214	.246	.283	.348	.381	.192	.207
32	64.94	-34	-582	-471	-.091	-.044	-.001	-.024	-.004	.099	.135	.158	.225	.278	.340	.395	.395	.232	.308
3	84.48	-124	-538	.586	-.184	-.112	-.082	-.030	-.020	.067	.117	.146	.230	.308	.383	.443	.429	.366	.397
33	49.98	-144	-658	-886	-238	-156	-094	-088	-005	.046	.106	.139	.239	.318	.404	.429	.390	.438	
4	44.90	-164	-668	-694	-295	-195	-127	-080	-019	.042	.106	.142	.254	.343	.487	.522	.440	.487	
34	39.98	-1.86	-676	-740	-260	-241	-163	-105	-037	.081	.103	.142	.268	.368	.469	.554	.570	.483	.584
5	34.90	-2.10	-701	-805	-453	-313	-227	-163	-084	.012	.089	.135	.272	.382	.498	.586	.603	.523	.580
35	29.96	-2.30	-704	-841	-550	-374	-277	-198	-109	.016	.074	.132	.286	.408	.534	.618	.650	.569	.680
6	24.90	-2.54	-722	-898	-694	-488	-367	-274	-170	.068	.110	.290	.436	.578	.660	.683	.630	.677	
36	19.98	-2.76	-772	-959	-891	-683	-498	-374	-245	-116	.006	.088	.200	.469	.627	.714	.745	.677	.742
7	14.94	-2.90	-808	-1.002	-1.185	-0.861	-0.72	-0.518	-0.368	-0.195	-.044	.067	.825	.526	.697	.809	.809	.756	.817
37	9.96	-2.86	-887	-1.049	-1.162	-1.106	-0.948	-0.726	-0.507	.209	-.091	.058	.883	.623	.813	.904	.920	.867	.921
8	7.38	-2.72	-916	-1.003	-2.071	-1.469	-1.166	-0.877	-0.622	.863	-.112	.074	.448	.709	.896	.984	1.000	.935	.978
38	4.94	-2.46	-978	-1.140	-2.739	-1.913	-1.490	-1.142	-0.805	.439	-.119	.107	.553	.828	.986	1.032	1.000	.978	
9	2.92	-2.08	-1.056	-1.861	-3.776	-2.502	-1.989	-1.480	-0.977	.478	-.062	.221	.781	.988	1.025	1.000	.968	.975	
39	1.66	-1.60	-1.561	-2.089	-4.985	-3.860	-2.495	-1.734	-1.070	.426	-.067	.401	.907	1.004	.867	.745	.650	.781	.709
10	1.92	-1.20	-1.601	-2.577	-6.834	-3.923	-2.821	-1.840	-1.020	.207	.300	.638	1.014	.864	.854	.661	.115	.275	.186
40	0.36	-70	-2.947	-4.077	-7.407	-4.167	-2.778	-1.605	-0.558	.157	.688	.926	.918	.180	-1.153	-1.819	-2.089	-1.088	-1.174
11	0	-1.978	-2.617	-5.265	-2.388	-1.232	-0.299	.368	.842	1.021	.957	.121	-1.070	-4.034	-4.755	-5.035	-3.456	-3.151	
41	0	.68	-1.232	-1.472	-2.035	-.572	.164	.666	.946	1.007	.871	.501	.923	-3.108	-5.717	-6.030	-7.153	-4.044	-3.977
12	.44	1.56	.390	.369	-.023	.756	.060	1.011	.987	.716	.340	-.170	.1.673	.850	.526	.526	.676	.634	.406
42	.94	2.16	.760	.767	.641	.978	1.022	.943	.774	.440	.038	.478	.1.824	.847	.525	.525	.911	.347	.233
13	1.70	2.78	.968	.986	.935	1.000	.950	.702	.577	.232	.148	.604	.1.752	.838	.474	.474	.750	.468	.1.598
43	2.94	3.64	1.014	1.022	1.007	.896	.774	.590	.343	.010	.335	.715	.1.652	.2.042	.3.578	.3.890	.3.775	1.784	1.138
14	4.98	.960	.943	.928	.702	.552	.347	.125	.180	.473	.708	.1.544	-.2.837	.3.065	-.3.208	-.3.045	1.217	.878	
44	7.50	5.74	.881	.806	.778	.512	.354	.153	.056	.328	.597	.877	.1.454	-.2.075	-.2.613	-.2.725	-.2.471	.920	.859
15	9.96	6.56	.718	.084	.045	.868	.214	.024	.165	.410	.640	.877	.1.981	.2.858	-.2.438	-.2.137	.819	.808	
45	12.68	7.34	.602	.566	.519	.239	.092	.084	.263	.489	.684	.888	.1.350	.809	-.2.154	-.2.200	1.834	.806	.826
16	14.92	7.88	.512	.476	.426	.153	.017	.168	.317	.525	.704	.898	.1.311	.716	.1.996	-.2.024	1.643	.780	.765
46	17.44	8.40	.426	.390	.340	.074	-.058	-.216	-.371	.501	.722	.902	.1.275	.634	-.1.863	-.1.855	1.452	.780	.769
17	19.96	6.80	.851	.818	.264	.010	-.116	-.220	-.406	.588	.738	.902	-.1.285	-.1.555	1.741	-.1.723	1.293	.758	.729
47	22.44	9.18	.282	.247	.196	-.051	-.170	-.313	-.442	.618	.758	.912	-.1.291	-.1.504	1.648	-.1.611	1.166	.747	.729
18	24.92	9.52	.218	.193	.142	-.091	-.202	-.338	-.483	.616	.740	.884	-.1.164	1.418	1.528	-.1.600	1.038	.740	.704
48	27.44	9.62	.164	.143	.096	-.127	-.234	-.300	-.471	.618	.737	.873	-.1.126	1.360	1.429	-.1.372	.911	.733	.704
19	30.88	9.76	.117	.103	.004	-.152	-.262	-.371	-.471	.611	.719	.841	-.1.074	1.275	1.325	-.1.281	.847	.715	.683
49	34.98	9.90	.036	.028	.003	-.195	-.281	-.385	-.475	.507	.686	.794	-.1.984	1.146	1.183	-.1.038	.704	.676	
50	39.90	9.54	-.015	.012	.033	-.202	-.281	-.371	-.445	.554	.633	.726	-.877	-.1.006	-.943	-.846	.656	.636	.661
51	44.80	9.64	-.073	.042	.046	-.220	-.292	-.371	-.439	.532	.597	.676	.801	.898	.787	-.087	.608	.633	.661
52	46.92	9.22	-.098	.076	.065	-.202	-.263	-.328	-.389	.468	.521	.686	.688	.755	.616	.560	.592	.668	.658
53	54.92	8.76	-.180	-.094	-.069	-.191	-.245	-.302	-.383	.417	.464	.514	.597	.636	.488	-.496	.576	1.661	
54	60.94	8.16	-.170	-.127	-.087	-.191	-.241	-.292	-.335	.396	.420	.471	-.525	-.543	-.396	-.432	-.545	-.672	-.661
55	64.90	7.54	-.206	-.143	-.067	-.184	-.224	-.287	-.399	.351	.374	.414	-.446	-.328	-.401	-.529	-.579	-.665	
56	66.86	6.75	-.227	-.155	-.080	-.163	-.216	-.256	-.309	.313	.346	.383	-.342	-.281	-.337	-.496	-.608	-.661	
57	74.90	5.88	-.249	-.150	-.066	-.130	-.195	-.238	-.295	.228	.249	.274	-.238	-.249	-.305	-.496	-.661	-.654	
58	79.92	4.92	-.277	-.173	-.055	-.109	-.180	-.148	-.159	.184	.191	.206	-.156	-.231	-.273	-.464	-.661	-.661	
59	84.88	3.88	-.303	-.190	-.088	-.064	-.098	-.102	-.116	.123	.098	.087	-.206	-.273	-.464	-.625	-.636		
60	89.88	2.74	-.317	-.177	-.016	-.023	-.026	-.026	-.033	.028	.028	.041	-.191	-.268	-.449	-.597	-.622		
61	94.90	1.48	-.355	-.177	.060	.036	.060	.071	.067	.084	.064	.067	-.012	-.173	-.243	-.401	-.580	-.586	
62	96.00	.93	-.393	-.195	.103	.117	.124	.128	.135	.132	.121	.098	-.003	-.163	-.226	-.363	-.529	-.572	
63	100.00	0																	

\* Test, variable-density tunnel 1099-2; manometer liquid, tetrabromoethane.

† Test, variable-density tunnel 1098-1; manometer liquid, mercury.

TABLE I.—EXPERIMENTAL DATA

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 6,300,000; test numbers and manometer liquids given in footnotes.]

Orifices			Values of pressure coefficient, $P = \frac{p - p_\infty}{q}$ , for different angles of attack																
Designation	Station (percent c from L. B. of chord)	Ordinate (percent c above chord)	-20°	-16°	-12°	-8°	-6°	-4°	-2°	0°	2°	4°	8°	12°	16°	18°	20°	24°	30°
28.	100.00	0	-0.106	0.207	0.234	0.208	0.205	0.196	0.180	0.167	0.181	0.177	0.167	0.159	0.148	0.138	0.128	0.118	0.108
1.	97.92	-16	-0.185	0.155	0.148	0.177	0.186	0.181	0.177	0.167	0.182	0.172	0.162	0.155	0.146	0.136	0.126	0.116	0.106
29.	94.86	-16	-0.286	0.129	0.112	0.145	0.150	0.167	0.168	0.171	0.165	0.179	0.162	0.155	0.146	0.136	0.126	0.116	0.106
2.	89.90	-22	-0.272	0.089	0.077	0.118	0.128	0.148	0.160	0.168	0.169	0.200	0.204	0.216	0.181	0.146	0.102	0.028	0.028
30.	84.94	-28	-0.338	0.043	0.042	0.078	0.082	0.118	0.129	0.143	0.154	0.194	0.209	0.251	0.226	0.208	0.192	0.169	0.169
31.	74.92	-52	-0.411	0.019	0.011	0.044	0.068	0.104	0.126	0.160	0.169	0.230	0.268	0.312	0.295	0.294	0.172	0.198	
32.	64.94	-34	-0.506	0.115	0.088	0.008	0.027	0.072	0.122	0.187	0.164	0.244	0.297	0.356	0.355	0.373	0.268	0.303	
3.	54.48	-124	-0.620	0.141	0.071	0.025	0.080	0.072	0.114	0.152	0.251	0.323	0.390	0.408	0.426	0.355	0.399		
28.	49.98	-144	-0.628	0.176	0.105	0.056	0.008	0.048	0.100	0.150	0.253	0.333	0.416	0.425	0.451	0.416	0.452		
4.	44.90	-164	-0.725	0.306	0.228	0.184	0.076	0.008	0.046	0.100	0.152	0.271	0.341	0.452	0.468	0.504	0.428	0.468	
34.	89.98	-186	-0.776	0.369	0.272	0.177	0.118	0.088	0.027	0.087	0.142	0.278	0.375	0.495	0.521	0.530	0.477	0.512	
5.	84.90	-210	-0.829	0.455	0.333	0.225	0.149	0.084	0.010	0.078	0.142	0.289	0.390	0.512	0.588	0.504	0.521	0.584	
35.	80.98	-230	-0.890	0.550	0.408	0.252	0.194	0.098	0.014	0.066	0.138	0.304	0.426	0.547	0.582	0.617	0.584	0.608	
6.	74.90	-254	-0.934	0.680	0.515	0.377	0.278	0.155	0.067	0.087	0.124	0.311	0.452	0.599	0.625	0.669	0.617	0.680	
36.	19.98	-276	-0.985	0.899	0.664	0.490	0.372	0.231	0.113	0.002	0.102	0.320	0.484	0.652	0.680	0.721	0.689	0.721	
7.	14.91	-290	-1.065	1.188	0.881	0.676	0.511	0.384	0.184	0.048	0.077	0.343	0.537	0.713	0.750	0.800	0.789	0.782	
37.	9.98	-285	-1.117	1.700	1.221	0.975	0.723	0.482	0.282	0.118	0.059	0.394	0.630	0.828	0.886	0.848	0.886		
8.	7.88	-272	-1.268	2.110	1.482	1.159	0.869	0.585	0.347	0.126	0.081	0.467	0.732	0.918	0.930	0.955	0.938	0.930	
38.	4.94	-246	-1.879	2.790	1.951	1.508	1.122	0.785	0.432	0.143	0.116	0.589	0.838	0.991	0.991	1.000	0.980	0.965	
9.	2.92	-2.06	-1.935	3.825	2.569	1.992	1.466	0.935	0.475	0.000	0.234	0.745	0.973	1.000	0.922	0.852	0.801	0.904	
39.	1.66	-1.60	-8.000	-5.070	-3.400	-2.498	-1.781	-1.029	-0.430	-0.087	-0.113	-0.413	-0.916	-1.008	-0.800	-0.592	-0.390	-0.291	-0.184
10.	.92	-1.20	-4.520	-6.510	-3.065	-2.825	-1.840	-0.988	-0.269	-0.044	-0.105	-0.665	-1.225	-1.202	-1.011	-1.238	-0.860		
40.	.86	-70	-5.600	-7.400	-4.210	-2.770	-1.569	-0.803	-0.184	-0.053	-0.098	-0.582	-1.397	-2.222	-2.016	-2.100	-1.842		
41.	0	0	-4.410	-5.460	-2.485	-1.286	-0.341	-0.892	-0.830	0.004	0.071	-0.185	-1.530	-4.035	-5.880	-6.030	-4.885	-3.225	
12.	.44	1.58	-0.080	-0.071	.780	.949	1.008	.950	.726	.862	.129	-1.700	-8.762	-6.261	-7.475	-8.480	-5.800	-8.730	
42.	.94	2.16	.982	.617	.922	1.006	.948	.771	.459	.073	.436	-1.798	-8.423	-6.420	-6.265	-6.820	-4.770	-2.482	
13.	1.70	2.78	.896	.918	.965	.936	.794	.507	.345	.128	.593	-1.744	-8.072	-4.590	-5.725	-5.790	-4.671		
43.	2.94	3.04	1.000	1.000	.987	.758	.578	.327	.017	.019	.711	-1.680	-2.658	-3.818	-4.655	-4.850	-4.001		
14.	4.90	4.68	.056	.918	.885	.589	.341	.101	.000	0.000	.883	-1.544	-2.800	-3.642	-3.820	-4.080	-3.760		
44.	7.80	5.74	.826	.705	.480	.844	.166	.068	.318	.559	.824	-1.424	-2.070	-2.763	-3.050	-3.148	-3.055	-3.723	
15.	9.95	6.56	.721	.620	.347	.204	.028	.181	.406	.616	.874	-1.391	-1.983	-2.423	-2.720	-2.763	-2.264	-3.705	
45.	12.58	7.34	.608	.495	.216	.084	.046	.278	.480	.608	.905	-1.369	-1.860	-2.476	-2.400	-2.128	-1.705		
16.	14.92	7.89	.529	.416	.188	.005	.145	.326	.518	.690	.895	-1.311	-1.728	-2.128	-2.285	-2.240	-1.004	-3.705	
46.	17.44	8.40	.448	.313	.061	.001	.008	.068	.143	.210	.902	-1.272	-1.644	-1.989	-2.129	-2.080	-1.956		
17.	19.90	8.80	.878	.234	.010	.120	.181	.460	.612	.759	.919	-1.287	-1.871	-1.874	-1.989	-1.825	-1.688		
47.	22.44	9.16	.812	.164	.072	.181	.314	.460	.612	.759	.919	-1.280	-1.875	-1.752	-1.908	-1.680			
18.	24.92	9.52	.261	.112	.108	.208	.324	.463	.608	.783	.886	-1.170	-1.441	-1.665	-1.752	-1.885	-1.680		
48.	27.44	9.62	.207	.077	.182	.282	.388	.478	.610	.734	.871	-1.128	-1.809	-1.040	-1.422	-1.840	-1.688		
19.	29.88	9.76	.164	.051	.158	.260	.300	.475	.599	.713	.840	-1.075	-1.293	-1.466	-1.528	-1.282	-1.680		
49.	34.08	9.90	.108	-.002	.176	.280	.377	.476	.567	.681	.794	-0.688	-1.164	-1.281	-1.809	-1.021	-1.795	-1.671	
50.	39.90	9.34	.042	.045	.211	.280	.386	.452	.546	.627	.728	-0.882	-1.027	-1.126	-1.820	-1.777	-1.688		
51.	44.80	9.04	-.002	-.003	.219	.205	.388	.442	.520	.503	.677	-0.806	-0.920	.069	.051	.073	.068		
52.	49.92	9.23	.011	-.003	.219	.268	.328	.301	.461	.615	.685	.697	.779	.811	.777	.585	.750	.688	
53.	54.92	8.76	-.028	-.007	.202	.244	.369	.350	.414	.458	.519	-.003	-.068	-.072	-.029	.518	.760	.688	
54.	59.94	8.16	-.068	-.124	.211	.244	.393	.391	.426	.471	.586	-.582	-.568	-.594	-.472	-.780	-.688		
55.	64.90	7.64	-.080	-.115	.185	.219	.261	.298	.389	.488	.540	-.488	-.487	-.411	-.420	-.784	-.688		
56.	69.88	6.76	-.038	-.106	.168	.190	.233	.250	.368	.407	.540	-.872	-.833	-.376	-.707	-.680			
57.	74.90	5.88	-.097	-.080	.115	.155	.181	.200	.298	.345	.467	-.282	-.272	-.272	-.359	-.707	-.688		
58.	79.92	4.92	-.097	-.080	.068	.123	.141	.152	.174	.181	.198	-.179	-.179	-.168	-.246	-.893	-.680		
59.	84.88	8.88	-.100	-.080	-.024	-.076	-.088	-.094	-.100	-.107	-.116	-.105	-.090	-.100	-.202	-.806	-.684	-.671	
60.	89.88	2.74	-.097	-.007	-.002	-.012	-.015	-.016	-.021	-.016	-.022	-.010	-.017	-.017	-.178	-.289	-.689	-.683	
61.	94.90	1.48	-.106	-.077	-.008	-.072	-.073	-.076	-.084	-.080	-.076	-.080	-.080	-.084	-.254	-.576	-.628		
62.	98.00	.08	-.132	.112	.155	.185	.141	.148	.148	.137	.118	.085	-.028	-.028	-.219	-.542	-.610		
63.	100.00	0																	

\* Test, variable-density tunnel 1096-2; manometer liquid, mercury.

† Test, variable-density tunnel 1096-3; manometer liquid, tetrabromomethane.

TABLE II.—EXPERIMENTAL DATA

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 8,200,000; test numbers and manometer liquids given in footnotes]

Designation	Orifices		Values of pressure coefficient, $P - P_\infty$ , for different angles of attack																
	Station (percent c from L. E. of chord)	Ordinate (percent c above chord)	-20°	-10°	-12°	-8°	-6°	-4°	-2°	0°	2°	4°	8°	12°	16°	18°	20°	24°	30°
28	100.00	0	-0.421	-0.199	0.114	0.198	0.217	0.204	0.207	0.200	0.181	0.158	0.124	0.101	0.010	-0.062	-0.173	-0.466	-0.518
1	97.92	-16	-0.454	-0.251	0.159	0.234	0.181	0.178	0.180	0.183	0.164	0.157	0.167	0.140	0.121	0.094	0.049	-0.291	-0.304
29	94.86	-16	-0.496	-0.291	0.107	0.186	0.153	0.151	0.158	0.168	0.154	0.166	0.180	0.166	0.179	0.166	0.127	-0.160	-0.167
2	89.90	-22	-0.505	-0.330	0.074	0.153	0.122	0.128	0.140	0.156	0.152	0.160	0.208	0.199	0.231	0.287	0.224	-0.080	-0.086
30	84.94	-28	-0.588	-0.382	0.085	0.107	0.072	0.082	0.098	0.118	0.118	0.168	0.211	0.212	0.267	0.270	0.268	0.049	0.042
31	74.92	-52	-0.568	-0.454	-0.048	0.056	0.049	0.068	0.066	0.126	0.136	0.168	0.281	0.251	0.322	0.348	0.374	0.179	0.179
32	64.94	-34	-0.584	-0.589	-0.101	0.002	0.000	0.028	0.062	0.104	0.120	0.154	0.244	0.283	0.374	0.407	0.453	0.270	0.289
3	54.48	-124	-0.571	-0.643	-0.199	-0.082	-0.063	-0.024	-0.021	0.072	0.100	0.157	0.250	0.309	0.414	0.452	0.492	0.348	0.368
33	49.98	-144	-0.571	-0.695	-0.262	-0.115	-0.099	-0.053	-0.005	0.060	0.091	0.134	0.252	0.316	0.426	0.472	0.581	0.381	0.407
4	44.90	-104	-0.571	-0.721	-0.304	-0.160	-0.128	-0.075	-0.017	0.048	0.088	0.140	0.268	0.342	0.459	0.505	0.570	0.413	0.446
34	39.98	-1.86	-0.558	-0.754	-0.368	-0.206	-0.169	-0.105	-0.041	0.031	0.071	0.136	0.265	0.362	0.485	0.544	0.609	0.466	0.498
5	24.90	-2.10	-0.561	-0.773	-0.447	-0.258	-0.217	-0.146	-0.078	0.010	0.066	0.133	0.290	0.387	0.516	0.576	0.642	0.504	0.544
35	29.96	-2.20	-0.545	-0.756	-0.445	-0.330	-0.274	-0.190	-0.105	0.011	0.048	0.116	0.293	0.414	0.551	0.609	0.687	0.557	0.596
6	24.90	-2.54	-0.545	-0.806	-0.588	-0.427	-0.367	-0.266	-0.165	0.054	0.026	0.115	0.318	0.438	0.589	0.681	0.726	0.609	0.648
36	19.98	-2.76	-0.551	-0.819	-0.596	-0.591	-0.490	-0.365	-0.244	0.111	0.011	0.093	0.321	0.472	0.627	0.687	0.752	0.642	0.700
7	14.94	-2.90	-0.558	-0.825	-1.178	-0.709	-0.663	-0.502	-0.348	-0.180	-0.053	0.076	0.345	0.518	0.712	0.786	0.857	0.723	0.778
37	9.96	-2.88	-0.561	-0.832	-1.180	-1.143	-0.945	-0.716	-0.501	-0.279	-0.111	0.059	0.402	0.616	0.818	0.883	0.948	0.824	0.876
8	7.38	-2.72	-0.577	-0.916	-2.070	-1.407	-1.158	-0.867	-0.595	-0.333	-0.131	0.071	0.462	0.713	0.906	0.961	1.019	0.902	0.941
38	4.94	-2.46	-0.571	-0.897	-2.807	-1.861	-1.490	-1.106	-0.777	-0.428	-0.160	0.109	0.568	0.818	0.980	1.013	1.046	0.948	0.980
9	2.92	-2.06	-0.702	-1.243	-2.745	-2.468	-1.931	-1.380	-0.932	-0.467	-0.088	0.231	0.748	0.948	0.993	0.943	0.909	0.833	0.941
39	1.66	-1.60	-1.058	-1.947	-4.940	-3.198	-2.478	-1.709	-1.059	-0.436	0.028	0.409	0.916	0.974	0.791	0.596	0.433	0.802	0.713
10	.92	-1.20	-2.082	-3.212	-6.177	-3.770	-2.765	-1.812	-1.995	-0.268	0.254	0.643	1.018	0.881	0.264	-0.173	-0.518	0.083	0.244
40	.38	-1.70	-2.204	-4.200	-7.337	-4.052	-2.732	-1.589	-1.681	0.166	0.039	0.924	0.905	0.94	-1.379	-2.285	-3.012	-1.671	-1.059
41	0	0	-2.023	-3.438	-6.490	-2.397	-1.232	-0.296	0.386	0.834	0.989	0.952	1.167	-1.555	-3.648	-5.060	-6.078	-3.695	-2.382
12	.44	1.56	.322	.231	-0.043	.766	.965	.994	.948	.720	.336	-.202	-1.740	-3.738	-5.961	-7.125	-7.954	-4.698	-2.552
42	.94	2.16	.739	.720	.596	.974	1.009	.939	.770	.468	.055	-.456	-1.793	-3.309	-5.210	-6.110	-6.681	-3.851	-2.006
13	1.70	2.78	.926	.935	.888	1.000	.939	.782	.569	.248	-.148	-0.611	-1.743	-3.058	-4.478	-5.190	-5.620	-3.010	-1.249
14	2.94	3.64	.987	1.000	.974	.898	.761	.559	.382	.018	-.336	-0.728	-1.647	-2.637	-3.765	-4.255	-4.662	-2.200	-1.786
14	4.90	4.68	.922	.985	.996	.718	.542	.338	.110	.179	-.184	-0.813	-1.547	-2.343	-3.190	-4.370	-5.731	-1.529	-1.695
44	7.50	5.74	.804	.798	.762	.498	.344	.189	-.066	.312	-.568	-.881	-1.432	-2.057	-2.709	-3.281	-3.060	-1.235	-0.844
15	9.96	6.58	.687	.687	.022	.374	.208	.017	-.168	.388	-.623	-.872	-1.391	-1.912	-2.440	-2.662	-2.681	-1.059	-0.630
45	12.58	7.34	.583	.576	.498	.263	.089	-.091	-.271	.468	-.676	-.899	-1.350	-1.802	-2.240	-2.415	-2.382	-1.007	-0.611
16	14.92	7.38	.498	.485	.407	.178	.014	-.152	-.308	.500	-.700	-.912	-1.208	-1.769	-2.149	-2.285	-2.180	-0.956	-0.604
17	17.44	8.40	.414	.407	.329	.100	-.052	-.210	-.380	.587	-.721	-.910	-1.272	-1.620	-2.082	-2.464	-2.042	-0.910	-0.604
17	19.96	8.80	.835	.285	.267	.086	-.111	-.202	-.568	-.740	-.914	-.1289	-.1848	-.2141	-.2927	-.3155	-.598	-.870	-.598
47	22.44	9.16	.263	.257	.172	-.024	-.176	-.322	-.482	-.609	-.769	-.930	-.1244	-.1502	-.1788	-.2122	-.2165	-.591	-.691
18	24.92	9.52	.212	.211	.140	-.063	-.196	-.332	-.454	-.599	-.746	-.895	-.1163	-.1418	-.1640	-.1892	-.1925	-.591	-.691
48	27.44	9.62	.166	.165	.100	-.096	-.228	-.355	-.471	-.606	-.742	-.881	-.1222	-.147	-.1535	-.1773	-.1891	-.591	-.691
19	29.88	9.76	.114	.133	.068	-.114	-.241	-.364	-.469	-.594	-.722	-.851	-.1071	-.1280	-.1488	-.1683	-.1764	-.591	-.691
49	34.98	9.90	.086	.085	.009	-.154	-.275	-.381	-.473	-.596	-.693	-.804	-.962	-.1144	-.1269	-.1256	-.1005	-.760	-.591
20	39.90	9.34	.017	.009	-.080	-.178	-.272	-.370	-.447	-.542	-.635	-.732	-.830	-.1007	-.1099	-.1059	-.798	-.727	-.594
50	44.80	9.64	-.095	-.044	-.069	-.194	-.291	-.371	-.439	-.519	-.609	-.709	-.802	-.902	-.961	-.910	-.655	-.720	-.591
21	49.92	9.22	-.121	-.056	-.075	-.173	-.256	-.329	-.389	-.455	-.526	-.595	-.690	-.759	-.786	-.734	-.538	-.715	-.591
51	54.92	8.76	-.147	-.069	-.075	-.161	-.238	-.303	-.351	-.406	-.471	-.527	-.601	-.649	-.684	-.473	-.700	-.591	-.691
22	59.94	8.16	-.199	-.101	-.095	-.161	-.244	-.342	-.391	-.438	-.487	-.541	-.676	-.751	-.820	-.846	-.591	-.691	-.591
52	64.90	7.64	-.225	-.108	-.082	-.128	-.214	-.264	-.394	-.378	-.421	-.456	-.500	-.591	-.648	-.743	-.769	-.601	-.691
23	69.86	6.76	-.252	-.121	-.082	-.116	-.181	-.228	-.350	-.282	-.319	-.351	-.371	-.436	-.516	-.591	-.654	-.694	-.694
24	74.90	5.38	-.277	-.128	-.056	-.082	-.148	-.183	-.200	-.222	-.269	-.279	-.304	-.364	-.412	-.516	-.555	-.654	-.694
53	79.92	4.92	-.297	-.147	-.069	-.076	-.115	-.144	-.155	-.169	-.191	-.210	-.199	-.210	-.247	-.301	-.391	-.492	-.578
25	84.88	3.88	-.330	-.154	-.024	-.024	-.066	-.091	-.094	-.101	-.116	-.113	-.106	-.082	-.082	-.140	-.271	-.004	-.565
54	89.88	2.74	-.356	-.161	.022	.026	-.006	-.019	-.016	-.017	-.026	-.032	-.029	-.004	-.043	-.114	-.245	-.055	-.562
26	94.80	1.48	-.288	-.174	.076	.100	.073	.069	.078	.062	.076	.070	.079	.062	-.016	-.096	-.226	-.519	-.519
27	98.00	.68	-.434	-.200	.127	.168	.141	.139	.147	.150	.148	.127	.120	.088	-.004	-.076	-.300	-.479	-.506
28	100.00	0																	

\* Test, variable-density tunnel 1006; manometer liquid, mercury.

† Test, variable-density tunnel 1009-4; manometer liquid, tetrabromoethane.

TABLE IIa.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. O. A. 4412 airfoil; effective Reynolds Number, 100,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.479	0.0916	0.028	-0.418	-0.7	-19.3
-16	-0.425	0.0864	0.016	-0.354	-0.6	-15.4
-12	-0.401	0.0711	0.026	-0.288	-0.7	-11.3
-8	-0.364	0.0235	0.028	-0.196	-0.8	-7.2
-6	-0.370	0.0050	0.061	-0.067	-0.6	-5.4
-4	-0.191	0.118	0.067	-0.191	-0.3	-3.7
-2	0.225	0.227	0.030	0.026	0	-2.0
0	0.317	0.040	0.114	0.317	.5	-0.5
2	0.522	0.0038	0.108	0.521	.8	1.2
4	0.723	-0.0168	0.108	0.721	1.1	2.9
8	1.061	-0.094	0.059	1.064	1.7	6.8
12	1.224	-1.855	0.063	1.228	2.0	10.0
16	1.229	-2.080	0.058	1.238	2.0	14.0
18	1.011	-0.060	0.114	0.980	1.6	16.4
20	0.916	-0.0033	0.127	0.864	1.4	18.6
24	0.874	0.0070	0.127	0.795	1.3	22.7
30	0.945	0.0062	0.143	0.818	1.3	28.7

TABLE IIb.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 900,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.442	0.0900	0.013	-0.371	-0.6	-19.4
-16	-0.425	0.0852	0.020	-0.384	-0.6	-15.4
-12	-0.404	0.0670	0.019	-0.440	-0.7	-11.3
-8	-0.422	0.0215	0.049	-0.415	-0.7	-7.3
-6	-0.236	0.0000	0.086	-0.234	-0.4	-5.6
-4	-0.045	0.012	0.093	-0.046	-0.1	-3.9
-2	0.161	0.156	0.104	0.162	.3	-2.8
0	0.350	0.151	0.104	0.350	.5	-0.5
2	0.522	0.032	0.100	0.521	.8	1.2
4	0.690	-0.0210	0.093	0.690	1.1	3.9
8	0.909	-0.0368	0.082	1.000	1.6	6.4
12	1.242	-1.921	0.064	1.258	2.0	10.0
16	1.281	-2.410	0.052	1.299	2.1	13.9
18	1.129	-1.134	0.106	1.108	1.8	16.2
20	0.953	-0.162	0.134	.901	1.4	18.6
24	0.891	0.058	0.137	0.810	1.3	22.7
30	0.933	0.061	0.143	0.809	1.3	28.7

TABLE IIb.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 240,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.428	0.0896	0.013	-0.371	-0.6	-19.4
-16	-0.425	0.0852	0.020	-0.384	-0.6	-15.4
-12	-0.404	0.0670	0.019	-0.440	-0.7	-11.3
-8	-0.422	0.0215	0.049	-0.415	-0.7	-7.3
-6	-0.236	0.0000	0.086	-0.234	-0.4	-5.6
-4	-0.045	0.012	0.093	-0.046	-0.1	-3.9
-2	0.161	0.156	0.104	0.162	.3	-2.8
0	0.350	0.151	0.104	0.350	.5	-0.5
2	0.522	0.032	0.100	0.521	.8	1.2
4	0.690	-0.0210	0.093	0.690	1.1	3.9
8	0.909	-0.0368	0.082	1.000	1.6	6.4
12	1.242	-1.921	0.064	1.258	2.0	10.0
16	1.281	-2.410	0.052	1.299	2.1	13.9
18	1.129	-1.134	0.106	1.108	1.8	16.2
20	0.953	-0.162	0.134	.901	1.4	18.6
24	0.891	0.058	0.137	0.810	1.3	22.7
30	0.933	0.061	0.143	0.809	1.3	28.7

TABLE IIc.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 450,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.440	0.0912	0.014	-0.353	-0.6	-19.4
-16	-0.425	0.0844	0.023	-0.385	-0.6	-15.4
-12	-0.403	0.0655	0.013	-0.453	-0.7	-11.3
-8	-0.335	0.0051	0.086	-0.331	-0.5	-7.5
-6	-0.172	-0.044	0.102	-0.172	-0.3	-5.7
-4	0.001	-0.079	0.103	0.002	0	-4.0
-2	0.170	0.019	0.099	0.171	.3	-2.3
0	0.349	0.0113	0.096	0.349	.5	-0.5
2	0.520	-0.008	0.093	0.520	.8	1.2
4	0.704	-0.0244	0.092	0.704	1.1	2.9
8	1.014	-0.0978	0.080	1.018	1.6	6.4
12	1.225	-1.922	0.062	1.239	2.0	10.0
16	1.243	-2.432	0.048	1.261	2.0	14.0
18	1.156	-1.677	0.056	1.152	1.8	16.2
20	1.022	-0.0378	0.135	.975	1.5	18.5
24	0.906	0.0091	0.139	.824	1.3	22.7
30	0.945	0.0073	0.149	0.817	1.3	28.7

TABLE IIe.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number 1,800,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.582	0.0616	0.016	-0.542	-0.9	-15.1
-16	-0.640	0.059	0.025	-0.640	-1.0	-11.0
-12	-0.688	0.0407	0.101	-0.700	-0.6	-7.4
-8	-1.124	-0.0124	0.098	-1.182	-0.3	-5.7
-6	-0.009	0.0045	0.100	-0.009	0	-4.0
-4	0.170	0.0117	0.093	0.170	.3	-2.3
0	0.380	0.0085	0.097	0.380	.6	-0.6
2	0.581	-0.0047	0.094	0.580	.8	1.2
4	0.705	-0.0288	0.092	0.705	1.1	2.9
8	1.018	-0.1026	0.081	1.019	1.6	6.4
12	1.277	-0.2014	0.066	1.281	2.0	10.0
16	1.374	-0.2672	0.058	1.336	2.2	13.8
18	1.335	-0.2768	0.064	1.336	2.2	15.8
20	1.199	-0.2284	0.060	1.204	1.9	18.1
24	1.198	-1.138	-0.167	1.140	1.8	22.2
30	1.950	-0.0080	-0.149	0.826	1.3	28.7

TABLE IIe.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 3,400,000]

$\alpha$ (deg.)	$c_a$	$c_e$	$c_{m_e/t}$	$c_t$	$\alpha_i$ (deg.)	$\alpha_g$ (deg.)
-20	-0.713	0.0411	0.028	-0.656	-1.0	-19.0
-16	-0.761	0.058	.009	-0.730	-1.2	-14.8
-12	-0.725	-1.304	-1.03	-0.734	-1.2	-10.8
-8	-0.395	-0.0405	-0.098	-0.397	-0.6	-7.4
-6	-0.197	-0.128	-0.096	-0.194	-0.3	-5.7
-4	-0.031	0.0030	-0.095	-0.031	0	-4.0
-2	0.148	0.0104	-0.094	0.148	.2	-2.2
0	0.341	0.0086	-0.094	0.341	.5	-0.5
2	0.521	-0.0040	-0.098	0.520	.8	1.2
4	0.691	-0.0233	-0.090	0.692	1.1	2.0
8	0.994	-0.0933	-0.078	0.997	1.6	6.4
12	1.275	-0.2034	-0.060	1.290	2.0	10.0
16	1.456	-0.3171	-0.059	1.488	2.4	13.6
18	1.547	-0.3585	-0.079	1.581	2.5	15.5
20	1.470	-0.3292	-0.119	1.495	2.4	17.6
24	1.163	-1.103	-0.150	1.121	1.8	22.2
30	1.150	-0.1015	-0.160	1.048	1.7	28.3

## REPORT NO. 613—NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TABLE IIg.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 6,300,000]

$\alpha$ (deg.)	$c_n$	$c_s$	$c_{m_{n/s}}$	$c_t$	$\alpha_t$ (deg.)	$\alpha_0$ (deg.)
-20						
-16	-0.869	-0.0497	0.028	-0.849	-1.8	-14.7
-12	-0.712	-0.1245	-0.103	-0.722	-1.1	-10.9
-8	-0.410	-0.0417	-0.059	-0.412	-0.7	-7.3
-6	-0.209	-0.0155	-0.094	-0.210	-0.3	-5.7
-4	-0.036	.0029	-0.033	-0.036	0	-4.0
-2	.167	.0118	-0.02	.157	.2	-2.2
0	.333	.0079	-0.01	.333	.5	-1.5
2	.501	-0.0084	-0.067	.500	1.2	
4	.674	-0.0266	-0.088	.674	1.1	2.9
8	1.002	-0.0988	-0.080	1.000	1.6	6.4
12	1.300	-0.2128	-0.078	1.315	2.1	9.9
16	1.550	-0.3410	-0.064	1.584	2.5	13.5
18	1.683	-0.4020	-0.067	1.678	2.7	15.8
20	1.605	-0.4425	-0.061	1.661	2.6	17.4
24	1.300	-0.2329	-0.143	1.283	2.0	22.0
30	1.111	-0.1019	-0.171	1.014	1.6	28.4

TABLE IIIh.—INTEGRATED AND DERIVED CHARACTERISTICS

[N. A. C. A. 4412 airfoil; effective Reynolds Number, 8,200,000]

$\alpha$ (deg.)	$c_n$	$c_s$	$c_{m_{n/s}}$	$c_t$	$\alpha_t$ (deg.)	$\alpha_0$ (deg.)
-20	-0.592	0.0318	0.030	-0.545	-0.9	-19.1
-16	-0.767	-0.0170	-0.036	-0.742	-1.2	-14.8
-12	-0.722	-0.1264	-0.092	-0.782	-1.2	-10.5
-8	-0.372	-0.0445	-0.056	-0.374	-0	-7.4
-6	-0.210	-0.0161	-0.046	-0.211	-0.3	-5.7
-4	-0.026	.0043	-0.045	-0.026	0	-4.0
-2	.148	.0107	-0.092	.146	.2	-2.2
0	.338	.0098	-0.091	.338	.5	-1.5
2	.501	-0.0034	-0.067	.501	.8	1.2
4	.677	-0.0258	-0.087	.677	1.1	2.9
8	1.020	-0.1003	-0.084	1.024	1.6	6.4
12	1.275	-0.2048	-0.074	1.259	2.0	10.0
16	1.548	-0.3357	-0.068	1.579	2.5	13.8
18	1.626	-0.4040	-0.063	1.671	2.6	15.4
20	1.640	-0.4374	-0.060	1.690	2.7	17.3
24	1.212	-0.1888	-0.141	1.182	1.9	22.1
30	1.009	-0.0776	-0.146	.918	1.4	28.6